

**Notice of Allowability**

Application No.

10/060,944

Examiner

Zia R. Hashmi

Applicant(s)

KIKUCHI ET AL.

Art Unit

2881

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 8/12/03.
2. ☒ The allowed claim(s) is/are 1-24.
3. ☒ The drawings filed on 30 January 2002 are accepted by the Examiner.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All b) ☐ Some\* c) ☐ None of the:  
1. ☒ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).  
\* Certified copies not received: \_\_\_\_\_.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
(a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
8. ☐ CORRECTED DRAWINGS must be submitted.  
(a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached  
1) ☐ hereto or 2) ☐ to Paper No. \_\_\_\_\_.  
(b) ☐ including changes required by the proposed drawing correction filed \_\_\_\_\_, which has been approved by the Examiner.  
(c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. \_\_\_\_\_.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet.

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

- 1 ☒ Notice of References Cited (PTO-892)  
3 ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)  
5 ☐ Information Disclosure Statements (PTO-1449), Paper No. \_\_\_\_\_.  
7 ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
- 2 ☐ Notice of Informal Patent Application (PTO-152)  
4 ☐ Interview Summary (PTO-413), Paper No. \_\_\_\_\_.  
6 ☐ Examiner's Amendment/Comment  
8 ☒ Examiner's Statement of Reasons for Allowance  
9 ☐ Other

**DETAILED ACTION**

***Allowable Subject Matter***

1. Response to Office Action of May 5, 2003 was received on August 12, 2002.
2. Claims 1-24 are allowed.
3. The following is an examiner's statement of reasons for allowance:

With respect to independent claims 1, 2, 3, 7, 10, 13, and 22, prior art fails to disclose a method of inspecting a hole using a charged-particle beam ( CPB) to irradiate a hole formed on an etched layer on a substrate, detecting an electric current flowing between the inspected sample and the ground as a result of the irradiation, and finding the etch depth of the hole into the substrate of the inspected sample using a previously determined relationship between the current flowing through the reference sample and the ground to the etch depth of the hole into the substrate under inspection.

In the prior art, scanning electron microscopes (SEM) are used to image contact holes. In recent years, the aspect ratios ( depth/diameter ) of holes has increased, since the trend in the semiconducting industry of having smaller diameter holes because of the decrease in size of the elements formed on a substrate. Also these elements have tended to be formed in plural layers, thus increasing the depths. Therefore, the efficiency at which secondary electrons from inside holes are captured for SEM imaging, has decreased greatly, making it difficult to precisely determine the state of the formed contact hole. Furthermore, where contact holes are formed during a process for fabricating semiconductor devices, under etching may occur, leaving behind

a film in contact holes. In practice, contact holes extend into the substrate due to over etching and therefore extend into the substrate, thereby making it necessary to determine etch depth of the holes into the substrate.

The current invention provides a novel method of inspecting a contact hole or holes using a CPB in such a way that the state of the contact holes can be gauged as to how the holes are etched. There are several embodiments of the present invention for inspecting the state of the holes. In one of the embodiments, the inspection method comprises of the steps of: irradiating a region containing the holes with the CPB, the holes being formed in an etched layer on a substrate forming a sample to be inspected; detecting an electric current flowing between the sample and ground as a result of the irradiation; repeating these steps for plural regions previously established on the inspected sample; obtaining data about the distribution of etch depths of holes in the inspected sample into the substrate based on the detected current and on a relation of a reference sample and ground, the relation being previously found using the reference sample; and displaying a map based on the obtained data on a display unit.

Claims 4-6, 8-9, 11-12, 14-21, and 23-24 are allowed by virtue of their dependencies on independent claims 1, 2, 3, 7, 10, 13, and 22.

### ***Conclusion***

4. Matsui et al. disclose ( Pub. No : US 2002/0134936 A1 ) a wafer inspection system using charged particle beam for detecting contact holes formed in fabrication of patterns on wafers at high speeds.

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Zia Hashmi whose telephone number is (703) 305-0419. The examiner can normally be reached between 8.30 AM- 5 PM. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John R. Lee can be reached on (703) 308-4116

Zia Hashmi

September 11, 2003

A handwritten signature in dark ink, appearing to read 'Zia Hashmi', is written over a faint, circular official stamp. The signature is fluid and cursive.